

U.S. Patent Application No. 10/820,638
Amendment dated January 9, 2008
Reply to Office Action of October 9, 2007

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AMENDMENTS TO THE CLAIMS:

This listing of claims will replace all prior versions, and listings, of claims in the application:

LISTING OF CLAIMS:

1. (Currently amended) An electrochemical cell comprising an anode, a cathode, and an electrolyte, said electrolyte comprising at least one pyrazolium cation, an imidazolium cation, or a combination thereof; and at least one non-Lewis acid derived counter ion, wherein said electrochemical cell ~~has a consistent charge~~ charges and ~~discharges over~~ discharge cycling in a temperature range of from about 20°C to about 170°C, wherein said counter ion comprises an imide, BETI, methide, TF or any combination thereof, and forms a lithium salt selected from Liimide, LiBETI, Limethide or LiTF or a combination thereof, and wherein said electrochemical cell is rechargeable.

2. (Canceled)

3. (Canceled)

4. (Canceled)

5. (Original) The electrochemical cell of claim 1, wherein said electrolyte comprises a binary salt mixture comprising a mixture of single salts, at least one of which contains said pyrazolium cation or an imidazolium cation.

6. (Original) The electrochemical cell of claim 5, wherein said binary salt mixture comprises a second cation which differs from said imidazolium cation.

7. (Original) The electrochemical cell of claim 6, wherein said second cation is in the form of a lithium salt selected from LiBETI, Liimide, Limethide, or LiTF.

8. (Original) The electrochemical cell of claim 6, wherein said imidazolium cation and said second cation are each in the form of a salt and the two salts are different.

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9. (Original) The electrochemical cell of claim 6, wherein said imidazolium cation and said second cation are both in the form of a salt and at least one of the two salts comprises DMIBETI, EMIBETI, DMIimide, EMIimide DMIimethide, EMIimethide, DMITF, or EMITF.
10. (Original) The electrochemical cell of claim 5, wherein said binary salt mixture comprises a second cation which differs from said pyrazolium cation.
11. (Original) The electrochemical cell of claim 10, wherein said second cation is in the form of a lithium salt selected from LiBETI, Liimide, Limethide, or LiTF.
12. (Original) The electrochemical cell of claim 10, wherein said pyrazolium cation and said second cation are each in the form of a salt and the two salts are different.
13. (Original) The electrochemical cell of claim 10, wherein said pyrazolium cation and said second cation are both in the form of a salt and at least one of the two salts comprises DMPBETI, EMPBETI, DMPimide, EMPimide DMPmethide, EMPmethide, DMPTF, or EMPTF.
14. (Original) The electrochemical cell of claim 1, wherein said electrolyte comprises a ternary salt mixture comprising a mixture of three single salts, at least one of which contains said pyrazolium cation or said imidazolium cation.
15. (Original) The electrochemical cell of claim 14, wherein said ternary salt mixture comprises a second cation which differs from said imidazolium cation, and a third cation which differs from said imidazolium cation and said second cation.
16. (Original) The electrochemical cell of claim 15, wherein at least one of said second and third cations is in the form of a lithium salt selected from LiBETI, Liimide, Limethide, LiTF, or a combination thereof.

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17. (Original) The electrochemical cell of claim 15, wherein said imidazolium cation, said second cation, and said third cation are in the form of a salt, and one of the anions of the three salts is different from the other two.

18. (Original) The electrochemical cell of claim 15, wherein said imidazolium cation, said second cation, and said third cation are in the form of a salt, and the anions of the three salts are the same.

19. (Original) The electrochemical cell of claim 14, wherein said pyrazolium cation or said imidazolium cation, said second cation, and said third cation are in the form of a salt, and at least one of the three salts comprises DMPBETI, DMIBETI, EMPBETI, EMIBETI, DMPimide, EMPimide, DMIimide, EMIimide, DMPmethide, DMIimethide, EMPmethide, EMIimethide, DMPTF, DMITF, EMPTF, or EMITF.

20. (Original) The electrochemical cell of claim 17, wherein said imidazolium cation, said second cation, and said third cation are in the form of a salt, and at least one of the three salts comprises DMPBETI, DMIBETI, EMPBETI, EMIBETI, DMPimide, DMIimide, EMPimide, EMIimide, DMPmethide, DMIimethide, EMPmethide, EMIimethide, DMPTF, DMITF, EMPTF, or EMITF and another one of the three salts comprises LiBETI, Liimide, Limethide or LiTF.

21. (Original) The electrochemical cell of claim 1, wherein said pyrazolium cation, said imidazolium cation, or a combination thereof is present as a pyrazolium salt, an imidazolium salt, or a pyrazolium and imidazolium salts, together with dissolved lithium salts, which are distributed throughout a polymer matrix.

22. (Canceled)

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23. (Currently amended) The electrochemical cell of claim 22 1, wherein said anode comprises a lithium intercalated electrode material.

24. (Currently amended) The electrochemical cell of claim 22 1, wherein said anode comprises $\text{Li}_4\text{Ti}_5\text{O}_{12}$.

25. (Currently amended) The electrochemical cell of claim 22 1, wherein said cathode comprises $\text{Li}_x\text{Mn}_2\text{O}_4$; Li_xCoO_2 , modified $\text{Li}_x\text{Mn}_2\text{O}_4$ electrodes; $\text{Li}_x\text{Mn}_{2-x}\text{Cu}_x\text{O}_4$, wherein $0.1 < x < 0.5$; $\text{LiM}_{0.02}\text{Mn}_{1.98}\text{O}_4$, wherein M is selected from B, Cr, Fe, and Ti; a transition metal oxide; or an electrochemically active conductive polymer.

26. (Currently amended) The electrochemical cell of claim 22 1, wherein said cathode is LiCoO_2 , or LiFePO_4 .

27. (Currently amended) The electrochemical cell of claim 22 1, wherein said electrochemical cell has a ratio of capacity of said cathode capacity and capacity of said to anode capacity includes a capacity ratio of 2 or greater.

28. (Withdrawn) An electrochemical cell comprising an electrolyte, said electrolyte comprising a imidazolium cation-containing molten salt, together with a dissolved lithium salt, wherein said electrolyte exhibits an oxidation limit of greater than about 5V vs. lithium, reduction voltage less than 1.5 V vs. lithium, and a thermal stability of up to at least about 300° C.

29. (Withdrawn) The electrochemical cell of claim 28, wherein said electrolyte comprises a binary molten salt mixture comprising a mixture of single salts, at least one of which contains an imidazolium cation.

30. (Withdrawn) The electrochemical cell of claim 29, wherein said binary molten salt mixture comprises a second cation which differs from said imidazolium cation.

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31. (Withdrawn) The electrochemical cell of claim 30, wherein said second cation is in the form of a lithium salt selected from LiBETI, Liimide, Limethide, LiTF or a combination thereof.

32. (Withdrawn) The electrochemical cell of claim 30, wherein said imidazolium cation and said second cation are each in the form of a salt and the two salts are different.

33. (Withdrawn) The electrochemical cell of claim 30, wherein said imidazolium cation and said second cation are both in the form of a salt and at least one of the two salts comprises DMIBETI, EMIBETI, DMLimide, EMlimide, DMImethide, EMImethide, DMITF, or EMITF.

34. (Withdrawn) An electrochemical cell comprising an electrolyte, said electrolyte comprising a pyrazolium cation-containing molten salt, together with a dissolved lithium salt, wherein said electrolyte exhibits an oxidation limit of greater than about 5V vs. lithium, reduction voltage less than 1.5 V vs. lithium, and a thermal stability of up to at least about 300° C.

35. (Withdrawn) The electrochemical cell of claim 34, wherein said electrolyte comprises a binary molten salt mixture comprising a mixture of single salts, at least one of which contains an pyrazolium cation.

36. (Withdrawn) The electrochemical cell of claim 35, wherein said binary molten salt mixture comprises a second cation which differs from said pyrazolium cation.

37. (Withdrawn) The electrochemical cell of claim 36, wherein said second cation is in the form of a lithium salt selected from LiBETI, Liimide, Limethide, LiTF or a combination thereof.

38. (Withdrawn) The electrochemical cell of claim 36, wherein said pyrazolium cation and said second cation are each in the form of a salt and the two salts are different.

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39. (Withdrawn) The electrochemical cell of claim 36, wherein said pyrazolium cation and said second cation are both in the form of a salt and at least one of the two salts comprises DMPBETI, EMPBETI, DMPimide, EMPimide, DMPmethide, EMPmethide, DMPTF, or EMPTF.

40. (Withdrawn) The electrochemical cell of claim 28, wherein said electrolyte comprises a ternary molten salt mixture comprising a mixture of three single salts, at least one of which contains said imidazolium cation.

41. (Withdrawn) The electrochemical cell of claim 40, wherein said ternary molten salt mixture comprises a second cation which differs from said imidazolium cation, and a third cation which differs from said imidazolium cation and said second cation.

42. (Withdrawn) The electrochemical cell of claim 41, wherein at least one of said second and third cations is in the form of a lithium salt selected from LiBETI, Liimide, Limethide, LiTF or a combination thereof.

43. (Withdrawn) The electrochemical cell of claim 41, wherein said imidazolium cation, said second cation, and said third cation are in the form of a salt, and the anions of the three salts are the same.

44. (Withdrawn) The electrochemical cell of claim 43, wherein said imidazolium cation, said second cation, and said third cation are in the form of a salt, and at least one of the three salts comprises DMPBETI, DMIBETI, EMPBETI, EMIBETI, DMPimide, DMlimide, EMPimide, EMlimide, DMPmethide, DMImethide, EMPmethide, EMImethide, DMPTF, DMITF, EMPTF, or EMITF.

45. (Withdrawn) The electrochemical cell of claim 43, wherein said imidazolium cation, said second cation, and said third cation are in the form of a salt, and at least one of the three

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salts comprises DMPBETI, DMIBETI, EMPBETI, EMIBETI, DMPimide, DMIimide, EMPimide, EMImide, DMPmethide, DMIImethide, EMPmethide, EMImethide, DMPTF, DMITF, or EMPTF, and another one of the three salts comprises LiBETI, Li imide, Limethide, LiTF or a combination thereof.

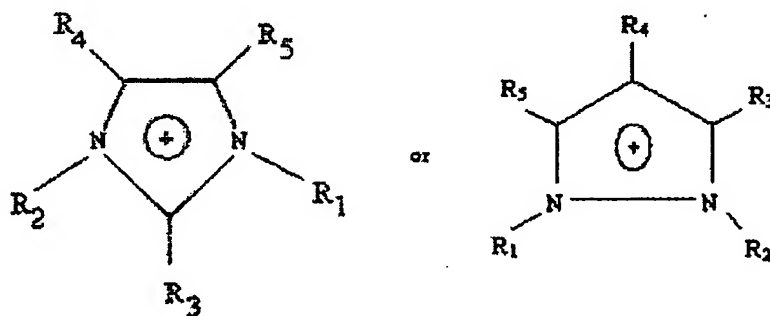
46. (Withdrawn) The electrochemical cell of claim 28, wherein said imidazolium cation is an imidazolium salt which is distributed throughout a polymer matrix.

47. (Withdrawn) The electrochemical cell of claim 34, further comprising an anode and a cathode.

48. (Withdrawn) The electrochemical cell of claim 47, wherein said anode comprises a lithium intercalated electrode material.

49. (Withdrawn) The electrochemical cell of claim 47, wherein said cathode comprises $\text{Li}_x\text{Mn}_2\text{O}_4$; Li_xCoO_2 ; modified $\text{Li}_x\text{Mn}_2\text{O}_4$ electrodes; $\text{Li}_x\text{Mn}_{2-x}\text{Cu}_x\text{O}_4$, wherein $0.1 < x < 0.5$; $\text{LiM}_{0.02}\text{Mn}_{1.98}\text{O}_4$, wherein M is selected from B, Cr, Fe, and Ti; a transition metal oxide; or an electrochemically active conductive polymer.

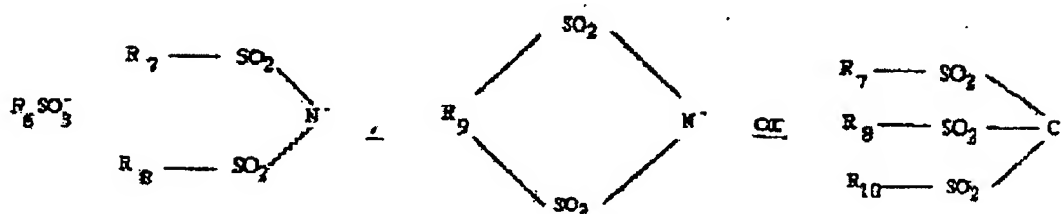
50. (Original) The electrochemical cell of claim 1, wherein said cation has the formula:



wherein R₁ and R₂ represent independently an alkyl group comprising 1-12 carbon atoms, and R₃, R₄, and R₅ represent independently, H or an alkyl group comprising from 1 to about 5 carbon atoms.

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51. (Currently amended) The electrochemical cell of claim 1, wherein said ~~anion~~ is selected non-Lewis acid derived counterion is:



where R₆, R₇, R₈ and R₁₀ are separate halogenated alkyl groups of 1 to 4 carbon atoms, and R₉ is a halogenated alkylene moiety of 2 to 6 carbon atoms.

52. (Original) The electrochemical cell of claim 1, wherein said cathode is LiCoO₂ or LiFePO₄ and said anode is Li intercalated electrode material.

53. (Currently amended) An electrochemical cell comprising an anode, a cathode, and electrolyte wherein said cell has a ratio of cathode capacity to anode capacity of 2 or greater, wherein the electrolyte comprises an imidazolium or pyrazolium cation and a non-Lewis acid derived anion.

54. (Original) The electrochemical cell of claim 53, wherein said ratio is greater than 2.2.

55. (Original) The electrochemical cell of claim 53, wherein said ratio is greater than 2.5.

56. (Original) The electrochemical cell of claim 53, wherein said ratio is from 2 to 3.

57. (Original) The electrochemical cell of claim 53, wherein said electrolyte comprises an imidazolium or pyrazolium cation and a non-Lewis acid derived anion.

58. (New) The electrochemical cell of claim 1, wherein for said consistent charge and discharge cycling said electrochemical cell has no more than a 2.3% capacity loss after 12 continuous cycles at 133° C.

59. (New) The electrochemical cell of claim 53, wherein said anode and said cathode has

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equal electrode area.